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ORIGINAL ARTICLE

Optimizing Clinical Utility of the Ultrasound-guided Core Biopsy for Head and Neck Tumor

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KEY WORDS
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Background: The goal of this study is to validate the clinical utility and define the procedure setting of minimally invasive core biopsy that is performed under ultrasound guidance with small-gauge needles (USCB) in head and neck tumors.
Materials and methods: A consecutive 56 patients with head and neck tumors received USCB with informed consents. Patients received USCB with different gauges of core needles randomly. The adequacy rate of the specimen and other clinical parameters were analyzed. The adequacy is defined as the target lesion is taken under ultrasound and specific diagnosis could be made by the specimen.
Results: The overall diagnostic adequacy rate of USCB was 91%. Among different needle gauges of USCB, the 18-gauge group demonstrated a 100% adequate rate, a lower anesthetic demand (16.6%), and shorter postprocedure bleeding time (3.0 ± 1.4 minutes), showing significant differences when compared with others. No immediate or late complications were noted after procedure in all patients.
Conclusion: USCB is minimally invasive and provides pathological information for diagnosis. It is a precise, safe, and office-based procedure and is suggested to be included in the diagnosis of head and neck tumors.

Conflicts of interest: none declared.

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Introduction

Head and neck tumors are frequently encountered in clinical practice, and always pose demanding challenges for accurate diagnosis and appropriate treatments. To make definite diagnoses of head and neck masses, many disease entities should be differentiated, ranging from congenital anomalies, infection, and inflammation to neoplastic lesions [1]. Because of the lengthy list of differential diagnosis of head and neck tumors, harvesting a tissue specimen for making a pathological diagnosis is a mandatory requirement in treating head and neck tumors.

In tumor tissue harvest, open biopsy remains the standard procedure for decades. Because of its nature of surgical intervention, the procedure of open biopsy has several disadvantages including wound and scar formation, time consumption, higher cost, and contraindications for patients with multiple comorbidities. In addition, open biopsy is not generally recommended because of its invasiveness and the possibility of complicating subsequent management. [2–4]. However, fine needle aspiration (FNA) has been used for small wounds and is free of anesthesia, is better tolerated, and has few complications [5]. To make the definite diagnosis by FNA, the accuracy is largely dependent on cytopathological expertise and techniques [6]. Nonetheless, even with experienced surgeons, the incidence of nondiagnostic results is approximately 10–15%. Most importantly, it is difficult to grade and classify tumors by FNA because the results are based on cytological analysis.

In light of the drawbacks related to open biopsy and FNA, core biopsy (CB) is another choice of diagnostic procedure. It is a well-established, tissue-obtaining technique that has been widely applied in many medical specialties, such as breast and renal tumors [7–13]. In the head and neck, it has been successfully used in tissue harvest of lymph nodes, thyroid lesions, parotid tumors, and pediatric craniofacial masses [10,13–18]. For head and neck malignancy, CB is suggested to be a safe and efficient tool for tissue harvest [19,20], especially when guided by ultrasound [14].

However, needles with 12–16 gauges, which were originally designed for breast and abdomen lesions, were used for head and neck tumors in the previous attempts [19,21–23]. It is believed that needles with larger gauges are associated with an increased possibility of bleeding, wound dehiscence, anesthetic requirement, and tumor seeding potential [24,25]. These disadvantages made large-gauge CB clinically impractical for head and neck tumors. Core needles with smaller gauges had been tried in cervicofacial lesions [8,26–29]. Until now, a comprehensive study that defines the CB procedure for a better diagnostic yield and utility in head and neck tumors is still lacking.

In this study, we will verify clinical utility of ultrasound-guided small-gauge core biopsy (USCB) and establish the procedure of USCB specific to head and neck tumors.

Materials and methods

Fifty-six consecutive patients receiving USCB for their head and neck mass were enrolled in this study. Complete ear, nose, and throat field evaluation was performed in each patient and head and neck mass was confirmed by ultrasound examination. The study protocol was approved by the Institutional Review Board of National Taiwan University Hospital. Tumors smaller than 1 cm or with only cystic contents that were inappropriate for this procedure were excluded [30]. All eligible patients received sampling procedures with informed consent.

For the USCB procedure, patients were in the supine position with the neck hyperextended. A panoramic ultrasound examination of head and neck was performed prudently in each patient with a 12 MHz linear probe (Hitachi Hivision Avius with EUP-L75, Hitachi Aloka Medical, Tokyo, Japan or Toshiba Aplio SSA790 diagnostic ultrasound system, Tochigi-ken, Japan). Sonographic features and locations of the lesions were recorded. A color duplex model was used to avoid vasculature and exclude the presence of hypervascular tumor. After identifying the lesion of interest, the overlying skin was disinfected and draped. Under echo-guidance, the automatic adjustable biopsy needles (Temno Evolution™ Biopsy Devices, Cardinal Health Inc., Dublin, USA) that were 16 gauge (G), 18 G, or 20 G were used randomly for specimen harvest (Fig. 1). We used the core needles randomly in the beginning by a patients' chart number. However, pathological information tended to be satisfied in smaller needles during the study, so we used only 18 G and 20 G later. Two needle throw lengths (10 mm or 20 mm) could be adjusted for precise sampling. Local anesthesia (2% xylocaine) was injected at the subcutaneous area for core needle insertion. Local anesthesia was used only by patients' requests after detailed discussion. The core needle was inserted under ultrasound guidance like FNA, without any skin incision. We identified the needle into the mass under ultrasound and then pushed the inner needle forward. Then, the core needle was fired and the specimen was retained in the needle notch. Only one needle pass was done to avoid any possibility of tumor seeding. Bleeding was controlled with pressure and the wound was examined every minute to record bleeding time. Possible complications in the literature, including bleeding, hematoma, nerve palsy, and pneumothorax, were also monitored [25]. After the procedure, the patient was observed for 20 minutes before leaving, and followed up in regular clinic visits. All harvested samples were sent for staining and microscopic examination. The related clinical parameters and pathological findings were recorded and analyzed.

The diagnostic adequacy is defined as a definite diagnosis could be concluded by the specimen retrieved from USCB procedure. The adequacy rate was obtained by dividing the number of adequate samplings with the total number of specimens. The comparison of adequate rate was analyzed by the Fisher's exact test. The comparison of local anesthesia requirement was analyzed by a logistic regression test to calculate the odds ratio between different groups. The comparison of bleeding time between different USCB gauges was analyzed by the Kruskal-wallis post-hoc test. All statistical analysis was performed by IBM SPSS Statistics Version 22.0 (IBM Corporation, USA), and $p < 0.05$ was regarded as significant in all tests.

Results

In all 56 patients receiving USCB, there were 36 male and 20 female patients. The average age was 51 years

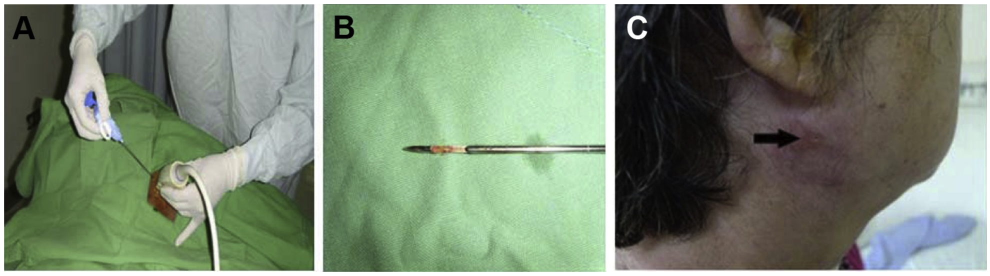

Fig. 1 Ultrasound-guided small-gauge core biopsy (USCB) procedure. (A) The needle was inserted into the tumor under ultrasound guidance. After localizing the mass and needle, the biopsy was taken. (B) The specimen harvested in the needle notch. (C) Surface wound after USCB procedure (arrow).

(16–96 years). The locations of head and neck tumors and their pathological diagnosis are listed in Tables 1 and 2.

The adequate rate was 91.1% for USCB totally. In the current study, 11 patients received a 16-G needle, 18 received 18-G needles, and 27 received 20-G needles. The adequate rate of diagnosis for 16-G, 18-G, and 20-G USCB was 100.0%, 100.0%, and 81.4%, respectively. In the comparison of each group, it was likely that the adequate rate of USCB was higher in the group with larger needle gauges. However, the difference was not significant statistically (Table 3).

The pain was more tolerable in smaller core needle size. Most patients didn't need local anesthesia by using 18- and 20-G needles (Odds ratio: 0.02 in 18 G and 0.016 in 20 G), with significant difference from 16 G (Table 4).

When bleeding time was measured and compared, it declined as the needle gauges decreased. Bleeding time was 4.1 ± 0.8 minutes in 16-G group, 3.0 ± 1.4 minutes in the 18-G group, and 2.6 ± 0.7 minutes in the 20-G group. There existed a significant difference between 16 G and other groups, which indicated that bleeding was correlated with needle gauge of core biopsy (Table 5).

In our series, no immediate complications such as uncontrollable bleeding, infection, or nerve injury were noted during and after the entire procedure for all patients. The USCB wound size was similar to that of FNA (Fig. 1). Two representative cases receiving USCB for diagnosis were demonstrated in Figs. 2 and 3. In the 1-year follow-up, no late complications or tumor seeding were found in USCB.

Table 1 Location of head and neck tumors.

		USCB
Case no.		56
Sex (M:F)		36:20
Age (y)		50.9 + 22.9
Size (cm)		2.26 + 1.02
Location		
Neck mass	Level I	12
	Level II	8
	Level III	7
	Level IV	7
	Level V	6
	Level VI	1
	Posterior neck	0
Parotid mass		10
Facial mass		4

USCB = ultrasound-guided small-gauge core biopsy.

Table 2 Diagnosis by ultrasound-guided, small-gauge core biopsy.

Classification	Pathologic diagnosis	Case no.
Malignant lesions		9
	MALToma	1
	Lymphoma, B cell, low grade	1
	Lymphoma, B cell, high grade	1
	Hodgkin's lymphoma	1
	Olfactory neuroblastoma	1
	Carcinoma, TTF-1 (+), metastasis	1
	Carcinoma, metastasis	2
	Clear cell carcinoma, metastasis	1
Benign lesions		42
	Warthin tumor	1
	Pleomorphic adenoma	1
	Sialoadenitis	1
	Lipoma	4
	Branchial cleft cyst	1
	Benign fibroadipose tissue	12
	Epidermal inclusion cyst	1
	Lymphoid hyperplasia	3
	Kikuchi disease	2
	Chronic/granulomatous inflammation	12
	Atypical lymphoepithelial lesion	4
Inadequate specimen		5

MALToma = mucosa-associated lymphoid tissue lymphoma.

Table 3 Adequate rate among core needles with different gauge sizes.

USCB	Case no.	Adequate rate (%)	*p*
16 G	11	100	0.052
18 G	18	100	
20 G	27	81.4	
Total	56	91	

USCB = ultrasound-guided small-gauge core biopsy.

Table 4 Odds ratio of local anesthesia among different core needle sizes.

Group	Percentage of local anesthesia	Odds ratio	*p*
16 G	6/11 (54.5%)	1	0.058
18 G	3/18 (16.6%)	0.02	0.041
20 G	5/27 (18.5%)	0.016	0.033

Table 5 Bleeding time among different core needle sizes.

Size	Bleeding time (min)	*p*
16 G	4.1 ± 0.8	0.001
18 G	3.0 ± 1.4	
20 G	2.6 ± 0.7	
Group comparison		*p*
16 G vs 18 G		0.008
18 G vs 20 G		$>$ 0.99
16 G vs 20 G		0.001

Discussion

In the current study, clinical utility of USCB in diagnosing head and neck tumor is demonstrated. The USCB is a precisely diagnostic, cost-effective, and patient-friendly procedure, which can be used in a variety of head and neck tumors by providing adequate and useful information for pathological diagnosis.

USCB is a safe procedure in sampling head and neck tumors. In other studies of CB by using needles with larger sizes, immediate and late complications including bleeding and hematoma, temporary nerve palsy, delayed wound healing, major vessel injury, and pneumothorax had been reported [25]. Nonetheless, in our series, there is no immediate complication after procedure. The wound is as small as that of FNA, and bleeding time is under control. By echo-guidance, the route of the biopsy needle is closely monitored. Vascular structures surrounding the tumor can be easily avoided to decrease complication risk. In addition, an automatic adjustable core needle was used in our patients instead of the automatic needle gun reported in previous studies [19,21,27,28]. The inner trocar of the adjustable needle, which is designed to define the most distant biopsy site, is important in making the procedure safer by restricting the outer cutting trocar. It can be immediately adjusted by tumor size. Additionally, this procedure can be performed in older patients, as shown in our results. Therefore, the device and procedure applied in USCB is beneficial to diminish sampling-related complications.

In addition to being a safe procedure, USCB is a precise sampling technique. Under ultrasound guidance, the area of target tumors can be clearly delineated. For instance, cystic and necrotic area within the tumor can be easily avoided. The adequacy rate of USCB is 91.1% in our series, which is in accordance with other studies using CB for head and neck sampling [14,19,27,28]. Furthermore, the adequacy rate of USCB is based on pathological diagnosis rather than cytological results, which is more accurate and useful in clinical applications. By using USCB, it is possible to make a definite pathological diagnosis by evaluating histological structure as well as applying special stains to assist differential diagnosis.

USCB is regarded as a patient-friendly procedure. USCB can be performed immediately during sonographic examination. Because sonographic examination is readily available at outpatient clinics, USCB can be an office-based procedure. It infers a convenient test with a low cost.

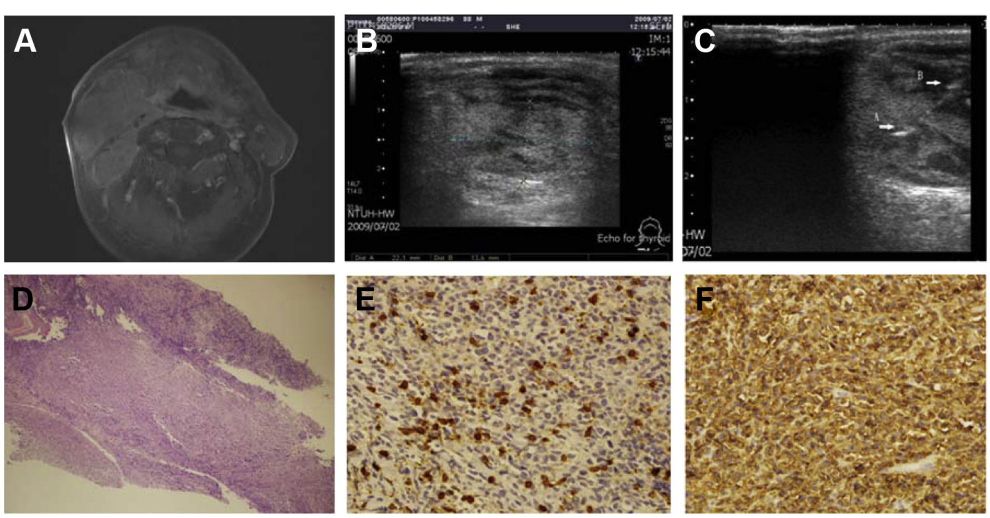

Fig. 2 An 86-year-old man had right neck swelling for 3 months. (A) Magnetic resonance imaging revealed a mass extending from Level I to Level V. (B) Neck ultrasound revealed a confluent, heterogeneous, ill-defined, and hypoechoic lesion at the right neck. (C) Under echo-guidance, core needle biopsy was performed smoothly. Arrow A defined the needle tip; the space between arrow A and B is the throw of the core needle. (D) Pathology results revealed a high grade B cell lymphoma (hematoxylin and eosin stain, 20×), which is positive for (E) CD20 (400×), and (F) CD3 (400×).

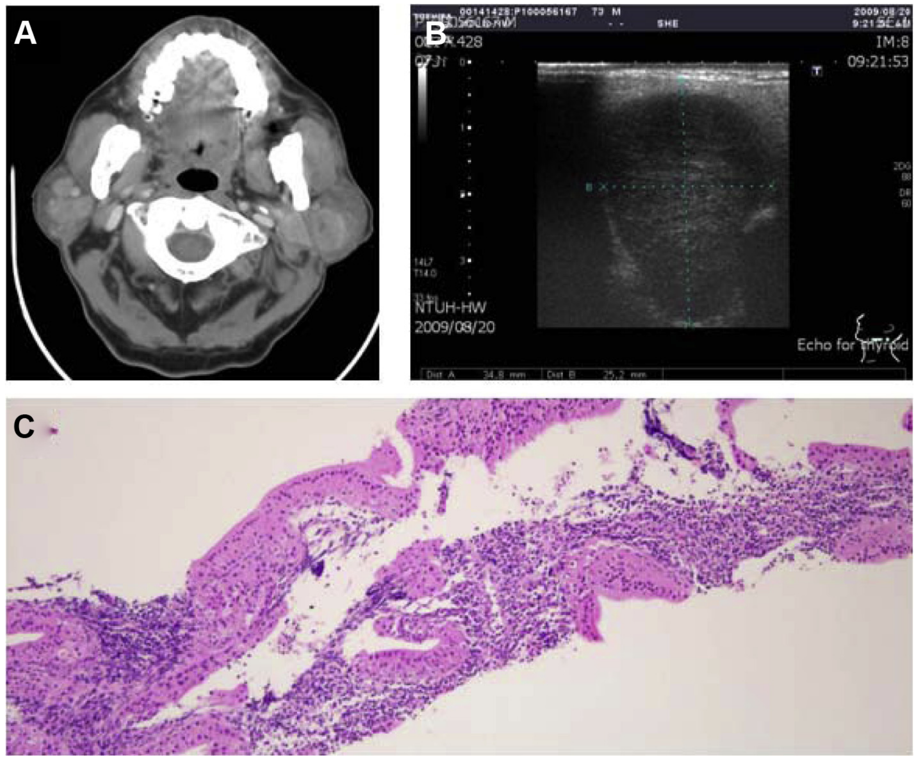

Fig. 3 A 73-year-old man had bilateral parotid tumors for 1 year. (A) Computed tomography scan shows bilateral parotid gland swelling. (B) Sonography revealed a well-defined ovoid hypoechoic mass. (C) Pathological diagnosis of ultrasound-guided small-gauge core biopsy-harvested specimen is Warthin tumor (hematoxylin and eosin stain, 100×).

Moreover, because the definite pathological diagnosis could be achieved via small needle wound, surgical intervention is unnecessary for many patients. It is particularly beneficial for patients who are vulnerable to operation, such as the infirm or those who have undergone radiation treatment [27]. Together, these features make USCB friendly to patients with head and neck tumors.

Tumor seeding and procedure-related complications are main issues that require additional study. It has been reported that significant tumor cell dissemination is seldom found in FNA biopsy by using a 21-G needle [31,32]. Although tumor seeding caused by CB also is rarely reported, some studies still conclude that tumor seeding is related to needle diameter, tumor feature, and anatomical site of puncture [24,33]. Therefore, to diminish the risk of tumor seeding and related complications, a smaller gauge core needle is more appropriate in the delicate anatomical region such as the head and neck. We use a smaller gauge and only one needle pass for each patient to avoid tumor seeding before malignancy is excluded. In this study, no tumor seeding was found in more than 1-year follow-up. It is acknowledged that a longer follow-up period is required to confirm the possibility of tumor seeding in USCB, current results offer preliminary evidence that the risk is clinically acceptable.

In the current study, a definitive diagnosis could not be made in five patients. All samples were harvested by 20-G needles with 10 mm throws. It may result from a small specimen without intact structure for evaluation. With a 20-G needle, the thickness of the specimen is smaller than 0.9 mm. With a 10-mm needle throw, the cannula thrust may cut inadequate tissue for diagnosis, especially in a hypervascular or lymphoma-like lesion. To overcome this shortage, a longer needle with 20-mm throw was used to obtain specimens instead. By using the revised procedure in clinical practice, no inadequate results had been found thereafter. In addition, we find that 18-G USCB can achieve a 100% adequacy rate and the same patient tolerance as a 20-G needle (low anesthesia rate and less bleeding time).

In conclusion, USCB is a precise and informative diagnostic procedure for head and neck tumors. It is a low-cost and office-based technique that can be easily performed. For most head and neck tumors, the most suitable gauge size is 18 G. It is competent in obtaining a high adequacy rate, providing pathological information, and causing less discomfort and fewer complications. Based on the advantages of minimal invasiveness and cost-effectiveness, USCB with an 18-G needle is suggested to be included in the battery of diagnostic procedures of head and neck tumors.

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